CHAPTER 5. CUMULATIVE IMPACTS

In its regulations for implementing the procedural provisions of NEPA, the Council on Environmental Quality (CEQ) defines cumulative impacts as follows: the impacts on the environment that result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions (40 CFR 1508.7). The cumulative impacts analysis presented in this chapter is based on the incremental actions associated with the highest potential impact for each resource area considered for all alternatives for HLW tank closure at the SRS, other actions associated with onsite activities, and offsite activities with the potential for related environmental impacts. The highest impact alternative varied based on the resource area being evaluated as shown in the data tables within this chapter.

> DOE has examined impacts of the construction and operation of SRS over its 50-year history. It has analyzed trends in the environmental characteristics of the site and nearby resources to establish a baseline for measurement of the incremental impact of tank closure activities and other reasonably foreseeable onsite and offsite activities with the potential for related environmental impact.

SRS History

In 1950, the U.S. Government selected a large rural area of nearly 400 square miles in southwest South Carolina for construction and operation of facilities required to produce nuclear fuels (primarily defense-grade plutonium and tritium) for the nation's defense. Then called the Savannah River Plant, the facility would have full production capability, including fuel and target fabrication, irradiation of the fuel in five production reactors, product recovery in two chemical separations plants, and waste management facilities, including the high-level waste tank farms (DOE 1980).

Construction impacts included land clearing, excavation, air emissions from construction vehicles, relocation of about 6,000 persons, and the formation of mobile home communities to house workers and families during construction; peak construction employment totaled 38,500 in 1952 (DOE 1980).

Socioeconomic effects stabilized quickly. The largest community on the Site, Ellenton, was relocated immediately north of the Site boundary and was renamed New Ellenton.

Aftereffects of construction are minimal. The site, later reduced to approximately 300 square miles, is predominately (73 percent) open fields and pine and hardwood forests. Twenty-two (22) percent is wetlands, streams, and reservoirs, and only five percent is dedicated to production and support areas, roads, and utility corridors (DOE 1997). The Savannah River Natural Resource Management and Research Institute (SRI) (formerly the Savannah River Forest Station) manages the natural resources at SRS. The SRI supports forest research, erosion control projects, and native plants and animals (through maintenance and improvements to their habitats). SRI sells timber, manages controlled-burns, plants new seedlings, and maintains secondary roads and exterior boundaries (Arnett and Mamatey 1997a).

Normal operations included non-radioactive and radioactive emissions of pollutants to the surrounding air and discharges of pollutants to onsite streams. Impacts to these releases to the environment were minimal. In addition, large withdrawals of cooling water from the Savannah River caused minimal entrainment and impingement of aquatic biota and severe thermal impacts due to the subsequent discharge of the cooling water to onsite streams. The thermal discharges stripped the vegetation along stream channels and adjacent banks and destroyed cypress-tupelo forests in the Savannah River Swamp. Thermal effects did not extend beyond the site boundary. In 1991, DOE committed to reforest the Pen Branch delta in the Savannah River Swamp using appropriate wetland species and to manage it until successful reforestation had been achieved (56 FR 5584-5587; February 11, 1991).

Groundwater contamination also occurred in areas of hazardous, radioactive, and mixed waste sites and seepage basins. Due to the large buffer area from the center of operations to the site boundary (approximately five miles), offsite effects were minimal. Groundwater contamination plumes did not move offsite, and onsite surface water contamination had minimal effect offsite because they are discharged to the Savannah River and diluted to concentrations that are well below concentrations of concern.

SRS has had a beneficial socioeconomic effect on employment in the region. The operations workforce varied from 7,500 (DOE 1980) to almost 26,000 (Halliburton NUS 1992), and presently numbers approximately 14,000 by February 2000 (DOE 2000a).

Over the years of operation, mitigation measures have substantially reduced onsite environmental stresses. DOE installed a Liquid Effluent Treatment Facility that minimized liquid releases of pollutants except tritium before discharge through a National Pollutant Discharge Elimination System outfall. Direct discharge of highly tritiated disassembly basin purge water to surface streams was replaced by discharge to seepage basins that enabled substantial decay during transport in the groundwater before their eventual outcrop to onsite streams. In addition, DOE eliminated thermal discharges with construction of a cooling lake for L-Reactor operation and a cooling tower intended to support K-Reactor operation.

Other agencies contributed to this trend by improving the quality and regulation of flows in the Savannah River. Five large reservoirs upriver of SRS were constructed in the 1950s through early 1980s. They have reduced peak flows in the Savannah River, moderated flood cycles in the Savannah River Swamp and, with the exception of a severe drought in 1985 through 1988, maintained flows sufficient for water quality and managing fish and wildlife resources downstream (DOE 1990). In 1975, the city of Augusta installed a secondary sewage treatment plant to eliminate the discharge of untreated or inadequately treated domestic and industrial waste into the Savannah River and its tributaries. Similarly, treatment facilities for Aiken County began operation in 1979 (DOE 1987).

In 1988, DOE placed the active site reactors on standby, and the end of the cold war resulted in permanent shutdown. DOE planted wetland hardwood species in 300-400 acres of the Pen Branch delta. Successful reforestation has begun and is ongoing.

Once operations ceased, key indicators of environmental impact decreased rapidly. For example, one discriminator for measuring impacts to human health is the dose to the *maximally exposed offsite individual* (MEI). The impact that it measures is the estimated probability of a latent cancer fatality, which is assumed to be directly proportional to dose. The estimate of latent cancers is, at best, an order of magnitude approximation. Thus an estimate of 10^{-5} latent cancer fatalities is likely between 10^{-6} and 10^{-4}. By 1996, the dose to the MEI (and the associated probability of a latent cancer fatality) decreased to about 1/8th of its 1987 value (Arnett and Mamatey 1997b). Further detail on the MEI is discussed later under public and worker health.

In general, the combination of mitigation measures and post-cold war cleanup efforts demonstrates an environmental trend of protecting and improving the quality of the SRS environment with minimal impact on the offsite environment. Although groundwater modeling indicates that most contaminants in the groundwater have reached their peak concentrations, several slow moving constituents would peak in this millennium at the 100-meter well (DOE 1987). Long-Term Cumulative Impacts are discussed further in Section 5.7 of this chapter.

CEQ Cumulative Effects Guidance

A handbook prepared by CEQ (1997) guides this chapter. In accordance with the handbook, DOE identified the resource areas in which tank closure could add to the impacts of past, present, and reasonably foreseeable actions within the project impact zones as defined by CEQ (1997).

Based on an examination of the environmental impacts of actions resulting from tank closure coupled with DOE and other agency actions, and some private actions it was determined that cumulative impacts for the following areas need to be presented: (1) air resources; (2) water resources; (3) public and worker health; (4) waste generation; (5) utilities and energy consumption; and (6) land use (long-term only). Discussion of cumulative impacts for the following resources is omitted because impacts from the proposed tank closure activities would be so small that their potential contribution to cumulative impacts would be very small: geologic resources, ecological resources, aesthetic and scenic resources, cultural resources, traffic, socioeconomics, and environmental justice.

In accordance with the CEQ guidance, DOE defined the geographic (spatial) and time (temporal) boundaries to encompass cumulative impacts on the five identified resources of concern.

Spacial and Temporal Boundaries

For determining the human health impact from airborne emissions the population within the 50-mile radius surrounding SRS was selected as the project impact zone. Although the doses are almost undetectable at the 50-mile boundary, this is the customary definition of the offsite public. For aqueous releases, onsite streams and the downstream population that uses the Savannah River as its source of drinking water was selected. Analyses revealed that other potential incremental impacts from tank closure, including air quality, waste management, and utilities and energy diminish within or quite near the site boundaries. The effective project impact zone for each of these is identified in the discussions that follow.

Nuclear facilities in the vicinity of SRS include Georgia Power's Plant Vogtle Electric Generating Plant across the river from SRS; Chem-Nuclear Inc., a commercial low-level waste burial site just east of SRS; and Starmet CMI, Inc. (formerly Carolina Metals), located southeast of SRS, which processes uranium-contaminated metals. Plant Vogtle, Chem-Nuclear, and Carolina Metals are approximately 11, 8, and 15 miles, respectively, from the SRS HLW Tank Farms. Other nuclear facilities are clearly too far (greater than 50 miles) to have a cumulative effect. Therefore, the project impact zone for cumulative impacts on air quality from radioactive emissions is 15 miles. Radiological impacts from the operation of the Vogtle Electric Generating Plant, a two-unit commercial nuclear power plant are minimal, but DOE has factored them into the analysis. *The SCDHEC Annual Report* (SCDHEC 1995) indicates that operation of the Chem-Nuclear Services facility and the Starmet CMI facility does not noticeably impact radiation levels in air or water in the vicinity of SRS. Therefore, they are not included in this assessment.

The counties surrounding SRS have numerous existing (e.g., Bridgestone Tire, textile mills, paper product mills, and manufacturing facilities) and planned industrial facilities with permitted air emissions and discharges to surface waters. Because of the distances between SRS and the private industrial facilities, there is little opportunity for interactions of plant emissions and no major cumulative impact on air or water quality. As indicated in results from the SRS Environmental Surveillance program report, ambient levels of pollutants in air and water have remained below regulatory levels in and around the SRS region (Arnett and Mamatey 1998).

An additional offsite facility with the potential to affect the nonradiological environment is South Carolina Electric and Gas Company's Urquhart Station. Urquhart Station is a three-unit, 250-megawatt, coal- and natural-gas-fired steam electric plant in Beech Island, South Carolina, located about 20 river miles and about 18 aerial miles north of SRS. Because of the distance between SRS and the Urquhart Station and the regional wind direction frequencies, there is little opportunity for any interaction of plant emissions, and no significant cumulative impact on air quality. Thus, the project impact zone for nonradiological atmospheric releases is less than 18 miles.

Finally, utility and energy capacity is available onsite and is too small to affect the offsite region. Similarly, onsite waste disposal capacity can satisfy the quantities generated by tank closure. Thus the extent of the project impact zone (from utilities, energy, and waste generation) is best described as the SRS boundary.

Temporal limits were defined by examining the period of influence from both the proposed action and other Federal and non-Federal actions that have the potential for cumulative impacts. Actions for tank closure are expected to begin in 2001.

With the exception of the long-term cumulative impacts described in Section 5.7, the period of interest for the cumulative impacts analysis for this EIS includes 2000 to 2030.

Reasonably Foreseeable DOE Actions

DOE also evaluated the impacts from its own proposed future actions by examining impacts to resources and the human environment as shown in NEPA documentation related to SRS (see Section 1.6). Additional NEPA documents related to SRS that are considered in the cumulative impacts section include the following:

- *Final Environmental Impact Statement - Interim Management of Nuclear Materials* (DOE/EIS-0220) (DOE 1995a). DOE is in the process of implementing the preferred alternatives for the nuclear materials discussed in the Interim Management of Nuclear Materials EIS. SRS baseline data in this chapter reflect projected impacts from implementation.

- *Final Environmental Impact Statement for the Accelerator Production of Tritium at the Savannah River Site* (DOE/EIS-0270) (DOE 1999a). DOE has proposed an accelerator design (using helium-3 target blanket material) and an alternate accelerator design (using lithium-6 target blanket material). If an accelerator were to be built, it would have been located at SRS. However, since the record of decision (64 FR 26369; May 14, 1999) states the preferred alternative as use of an existing commercial light-water reactor, data from this EIS are not used.

- *Environmental Assessment for the Tritium Facility Modernization and Consolidation Project at the Savannah River Site* (DOE/EA-1222) (DOE 1997). This environmental assessment addresses the impacts of consolidating the tritium activities currently performed in Building 232-H into the new Building 233-H and Building 234-H. Tritium extraction functions will be transferred to the Tritium Extraction Facility. The overall impact will be to reduce the tritium facility complex net tritium emissions by up to 50 percent. Another positive effect of this planned action will be to reduce the amount of low-level radioactive job-control waste. Effects on other resources will be negligible. Therefore, impacts from the environmental assessment have not been included in this cumulative impacts analysis.

- *Disposition of Surplus Highly Enriched Uranium Final Environmental Impact Statement* (DOE/EIS-0240) (DOE 1996). This cumulative impacts analysis incorporates blending highly enriched uranium at SRS to 4 percent low-enriched uranium as uranyl nitrate hexahydrate, as decided in the Record of Decision (61 FR 40619, August 5, 1996).

- *Final Environmental Impact Statement on Management of Certain Plutonium Residues and Scrub Alloy Stored at the Rocky Flats Environmental Technology Site* (DOE/EIS-0277F) (DOE 1998a). As stated in the record of decision (64 FR 8068; February 18, 1999), DOE will process certain plutonium-bearing materials being stored at the Rocky Flats Environmental Technology Site. These materials are plutonium residues and scrub alloy remaining from nuclear weapons manufacturing operations formerly conducted by DOE at Rocky Flats. DOE has decided to ship certain residues from the Rocky Flats Environmental Technology Site to SRS for plutonium separation and stabilization. The separated plutonium will be stored at SRS pending disposition decisions. Environmental impacts from using F Canyon to chemically separate the plutonium from the remaining materials at SRS are included in this section.

- *Draft and Final Environmental Impact Statement for the Construction and Operation of a Tritium Extraction Facility at the Savannah River Site* DOE/EIS-0271) (DOE 1998b, 1999b). As stated in the record of decision (64 FR 26369; May 14, 1999), DOE will construct and operate a Tritium Extraction Facility on SRS to provide the capability to extract tritium from commercial light water reactor targets and targets of similar design. The purpose of the proposed action and alternatives evaluated in the EIS is to provide tritium extraction capability to support either accelerator or reactor tritium production. Environmental impacts from the maximum processing option in both the draft and final EISs are included in this section. The final EIS presents responses to public comments and a record of changes to the draft EIS.

- *Surplus Plutonium Disposition Final Environmental Impact Statement* (DOE/EIS-0283) (DOE 1999d). This EIS analyzed the activities necessary to implement DOE's disposition strategy for surplus plutonium. As announced in the Record of Decision (65 FR 1608; January 11, 2000), SRS was selected for three disposition facilities, pit (a nuclear weapon component) disassembly and conversion, plutonium conversion and immobilization, and mixed oxide fuel fabrication. The DOE decision allows the immobilization of approximately 17 metric tons of surplus plutonium and the use of up to 33 metric tons of surplus plutonium as mixed oxide fuel. Both methods in this hybrid approach ensure that surplus plutonium produced for nuclear weapons is never again used for nuclear weapons. Impacts from this EIS are included in this section.

- *Defense Waste Processing Facility (DWPF) Supplemental Environmental Impact Statement* (DOE/EIS-0082-S) (DOE 1994). The selected alternative in the Record of Decision (60 FR 18589, April 12, 1995) was the completion and operation of the DWPF to immobilize HLW at the SRS. The facility is currently processing sludge from SRS HLW tanks. However, SRS baseline data are not representative of full DWPF operational impacts, including processing of salt and supernate from these tanks. Therefore, the DWPF data are listed separately.

- *Treatment and Management of Sodium-Bonded Spent Nuclear Fuel* (DOE/EIS-0306) (DOE 2000b). DOE has prepared a Final EIS for the Treatment and Management of Sodium-Bonded Spent Nuclear Fuel (65 FR 47987, August 4, 2000). One of the alternatives evaluated in the EIS would involve processing INEEL's sodium-bonded fuel inventory at SRS using the Plutonium-Uranium Extraction process. Because processing at SRS is a reasonable alternative to processing of INEEL, it has been included in this cumulative impact analysis. This method of stabilization of spent nuclear fuel could be used for the sodium-bonded spent nuclear fuel, most of which is currently in storage at INEEL. There are approximately 22.4 metric tons of heavy metal (MTHM) of Experimental Breeder Reactor-II (EBR-II) fuel and 34.2 MTHM of Fermi-1 fuel to be processed. This fuel would be declad before shipment to SRS. Because the decladding activities would occur at INEEL, the impacts of these decladding activities are not included in this chapter.

  In the Record of Decision (65 FR 56565; September 19, 2000), DOE decided to electrometallurgically treat the EBR-II fuel at Argonne National Laboratory-West. However, due to the different characteristics of the Fermi-1 fuel, DOE decided to continue to store this material while alternative treatments are evaluated.

- *Savannah River Site Spent Nuclear Fuel Management Final Environmental Impact Statement (DOE/EIS-0279)* (DOE 2000c). The proposed DOE action described in this EIS is to implement appropriate processes for the safe and efficient management of spent nuclear fuel and targets at SRS, including placing these materials in forms suitable for ultimate disposition. Options to treat, package, and store this material are discussed. The material included in this EIS consists of approximately 68 MTHM of spent nuclear fuel (20 MTHM of aluminum-based spent nuclear fuel at SRS, as much as 28 MTHM of aluminum-clad spent nuclear fuel from foreign and domestic research reactors to be shipped to SRS through 2035, and 20 MTHM of stainless-steel or zirconium-clad spent nuclear fuel and some programmatic material stored at SRS for repackaging and dry storage pending shipment offsite).

  In the Record of Decision (65 FR 48224; August 7, 2000), DOE decided to implement the Preferred Alternative. As part of the Preferred Alternative, DOE will develop and demonstrate the Melt and Dilute technology. Following development and demonstration of the technology, DOE will begin detailed design, construction, testing, and startup of a Treatment and Storage Facility (TSF). The SNF will remain in wet storage until treated and placed in dry storage in the TSF.

  DOE also decided to use conventional processing to stabilize about 3 percent by volume and 40 percent by mass of the aluminum-based SNF. DOE also decided to continue to store small quantities of higher actinide materials until DOE determines their final disposition. Finally, DOE decided to ship non-aluminum-based SNF from the SRS to the Idaho National Engineering and Environmental Laboratory.

Other materials under consideration for processing at SRS canyons include various components currently located at other DOE sites, including Oak Ridge, Rocky Flats, Los Alamos, and Hanford. These materials, which were identified during the processing needs assessment, consist of various plutonium and uranium components. If DOE were to propose to process these materials in the SRS chemical separations facilities, additional NEPA reviews would need to be performed. In this chapter, estimates of the impacts of processing these materials (DOE 2000b) have been included in the cumulative analysis. These estimates are qualitative because DOE has not yet proposed to process the materials. When considering cumulative impacts, the reader should be aware of the indeterminate nature of some of the actions for which impacts have been estimated.

In addition, the cumulative impacts analysis includes the impacts from actions proposed in this EIS. Risks to members of the public and site workers from radiological and nonradiological releases are based on operational impacts from the alternatives described in Section Chapter 4.

The cumulative impacts analysis also accounts for other SRS operations. Most of the SRS baseline data are based on 1998 environmental report information (Arnett and Mamatey 1999), which are the most recent published data available.

5.1 Air Resources

Table 5-1 compares the cumulative concentrations of nonradiological air pollutants from the SRS, including the tank closure alternative with the largest impact (the Saltstone Option under the Clean and Stabilize Tanks Alternative) to Federal and State regulatory standards. The listed values are the maximum modeled concentrations that could occur at ground level at the site boundary. The data demonstrate that total estimated concentrations of nonradiological air pollutants from SRS would in all cases be below the regulatory standards at the site boundary.

The highest percentages of the regulatory standards are for sulfur dioxide concentrations for the shorter time interval (approximately

Table 5-1. Estimated maximum cumulative ground-level concentrations of nonradiological pollutants (micrograms per cubic meter) at SRS boundary.[a]

Pollutant[b]	Averaging time	SCDHEC ambient standard ($\mu g/m^3$)[c]	SRS baseline[d] ($\mu g/m^3$)	Tank closure[e] ($\mu g/m^3$)	Other foreseeable planned SRS activities[f] ($\mu g/m^3$)	Maximum cumulative concentration[g] ($\mu g/m^3$)	Percent of standard
Carbon monoxide	1 hour	40,000	10,000	3.4	46.4	10,050	25
	8 hours	10,000	6,900	0.8	6.5	6,907	69
Oxides of nitrogen	Annual	100	26	0.07	7.7	33.8	34
Sulfur dioxide	3 hours	1,300	1,200	0.6	9.7	1,210	93
	24 hours	365	350	0.12	2.6	352.7	97
	Annual	80	34	0.006	0.19	34.2	43
Ozone[h]	1 hour	235	NA[i]	2.0	1.51	3.5	1.5
Lead	Max. quarter	1.5	0.03	4.1×10^{-6}	<0.00001	0.03	2
Particulate matter (≤10 microns aerodynamic diameter)[h]	24 hours	150	130	0.06	3.37	133.43	89
	Annual	50	25	0.03	0.15	25.2	50
Total suspended particulates ($\mu g/m^3$)	Annual	75	67	0.005	0.08	67.1	90

a. DOE (1994, 1996, 1997, 1998a,b, 1999c,d; 2000b,c).
b. Hydrochloric acid, formaldehyde, hexane, and nickel are not listed in Table 5-1 because tank closure or other foreseeable, planned SRS activities would not result in any change to the SRS baseline concentrations of these toxic pollutants.
c. SCDHEC (1976).
d. Source: Table 3.3-3.
e. Data based on the Saltstone Option under the Clean and Stabilize Tanks Alternative (Table 4.1.3-2).
f. Includes Spent Nuclear Fuel, Highly Enriched Uranium, Tritium Extraction Facility, Management of Certain Plutonium Residues and Scrub Alloy Concentrations, Defense Waste Processing Facility, and Disposition of Surplus Plutonium, Sodium-Bonded Spent Nuclear Fuel, and components from throughout the DOE complex.
g. Includes tank closure concentrations.
h. New NAAQS for ozone (1 hr replaced by 8 hr standard = 0.08 ppm) and particulate matter ≤ 2.5 microns (24 hr standard = 65 $\mu g/m^3$ and annual standard of 15 $\mu g/m^3$) may become enforceable during the stated temporal range of the cumulative impacts analyses.
NA = Not available.
$\mu g/m^3$ = micrograms per cubic meter.

97 percent of standard for the 24-hour averaging time and 93 percent of the standard for the 3-hour average time), for particulate matter of less than 10 microns (approximately 89 percent of standard for the 24-hour averaging time), and total suspended particulates (approximately 90 percent of standard). The remaining pollutant concentrations would range from under 2 to 69 percent of the applicable standards. The majority of the concentration comes from estimated SRS baseline concentrations and not tank closure and other foreseeable actions. The incremental impact from tank closure would not be noticeable. Also, it is unlikely that actual concentrations at ambient monitoring stations would be as high as that shown for the SRS baseline values. The SRS baseline values are based on the maximum potential emissions from the 1998 air emissions inventory and for all SRS sources, and observed concentrations from nearby ambient air monitoring stations.

DOE also evaluated the cumulative impacts of airborne radioactive releases in terms of dose to a maximally exposed individual at the SRS boundary and dose to the 50-mile population (see Table 5-2). Although comparable results for Plant Vogtle were not available for the nonradiological analysis (Table 5-1), DOE included the impacts of Plant Vogtle (NRC 1996) in this cumulative radioactive release total. The South Carolina Department of Health and Environmental Control Annual Report (SCDHEC 1995)

Table 5-2. Estimated average annual cumulative radiological doses and resulting health effects to the maximally exposed offsite individual and population in the 50-mile radius from airborne releases.

Activity	Offsite Population			
	Maximally exposed individual		50-mile population	
	Dose (rem)	Probability of fatal cancer risk	Collective dose (person-rem)	Excess latent cancer fatalities
SRS Baseline[b]	7.0×10^{-5}	3.5×10^{-8}	3.5	1.8×10^{-3}
Tank Closure[a]	5.2×10^{-8}	2.6×10^{-11}	3.0×10^{-3}	1.5×10^{-6}
Other foreseeable SRS activities[c]	5.1×10^{-5}	2.5×10^{-8}	3.4	1.7×10^{-3}
Plant Vogtle[d]	5.4×10^{-7}	2.7×10^{-10}	0.042	2.1×10^{-5}
Total	1.2×10^{-4}	6.1×10^{-8}	6.9	3.5×10^{-3}

a. Data is based on the Saltstone Option under the Clean and Stabilize Tanks Alternative (Table 4.1.8-1).
b. Arnett and Mamatey (1999) for 1998 data for maximally exposed individual and population.
c. Includes Spent Nuclear Fuel, Highly Enriched Uranium, Tritium Extraction Facility Management of Certain Plutonium Residues and Scrub Alloy Concentrations, Defense Waste Processing Facility, and Disposition of Surplus Plutonium, Sodium-Bonded Spent Nuclear Fuel, and components from throughout the DOE complex.
d. NRC (1996).

indicates that operation of the Chem-Nuclear low-level waste disposal facility just east of SRS does not noticeably impact radiation levels in air or water in the vicinity of SRS and thus are not included.

Table 5-2 lists the results of this analysis using 1998 emissions (1992 for Plant Vogtle) which are the latest available data for the SRS baseline. The cumulative dose to the maximally exposed member of the public would be 0.0001 rem (or 0.10 millirem) per year, well below the regulatory standard of 10 millirem per year (40 CFR 61). Summing the doses to the maximally exposed individual for the actions and baseline SRS operations listed in Table 5-2 is an extremely conservative approach because in order to get the calculated dose, the maximally exposed individual would have to occupy different physical locations at the same time, which is impossible.

Adding the population doses from current and projected activities at SRS, Plant Vogtle, and tank closure activities could yield a total annual cumulative dose of 6.9 person-rem from airborne sources. The total annual cumulative dose translates into 0.0035 excess latent cancer fatality for each year of exposure for the population living within a 50-mile radius of the SRS.

5.2 Water Resources

At present, a number of SRS facilities discharge treated wastewater to Upper Three Runs and its tributaries and Fourmile Branch via NPDES-permitted outfalls. These include the F- and H-Area Effluent Treatment Facility (ETF) and the M-Area Liquid Effluent Treatment Facility. As stated in Section 4.1.2, the SRS storm drainage system is designed to enable operators to secure specific storm sewer zones and divert potentially contaminated water to lined retention basins. Therefore, during the short term, tank closure activities are not expected to result in any radiological or nonradiological discharges to groundwater. Discharges to surface water would be treated to remove contaminants prior to release into SRS streams. Other potential sources of contaminants into Upper Three Runs during the tank closure activities period include the accelerator production of tritium, the tritium extraction facility, environmental restoration, and decontamination and decommissioning activities, as well as modifications to existing SRS facilities. Discharges associated with the accelerator production of tritium and tritium extraction facility activities would not add significant amounts of nonradiological contaminants to Upper Three Runs. The amount of discharge associated with environmental restoration and decontamination and decommissioning activities would vary based on the level of activity. All the potential activities that could result in wastewater discharges would be required to comply with the NPDES permit limits that ensure protection of the water quality needed to support state-designated uses for the receiving stream. Studies of water quality and biota in Upper Three Runs suggest that discharges from facilities outfalls have not degraded the stream (Halverson et al. 1997).

5.3 Public and Worker Health

Table 5-3 summarizes the cumulative radiological health effects of routine SRS operations, proposed DOE actions, and non-Federal nuclear facility operations (Plant Vogtle Electric Generating Facility). In addition to estimated radiological doses to the hypothetical maximally exposed offsite individual, the offsite population, and the involved workers population. Table 5-3 also lists the potential number of excess latent cancer fatalities for the public and workers due to exposure to radiation and the involved workers population and the risk of a latent cancer fatality to the maximally exposed offsite individual. The radiation dose to the maximally exposed offsite individual from air and liquid pathways would be 0.00035 rem (0.35 mrem) per year, which is well below the applicable DOE regulatory limits (10 mrem per year from the air pathway, 4 mrem per year from the liquid pathway, and 100 mrem per year for all pathways). The total annual population dose for current and projected activities of 8.9 person-rem translates into 0.0045 latent cancer fatality for each year of exposure for the population living within a 50-mile radius of the SRS. As stated in Section 5.1, for comparison, 144,000 deaths from cancer due to all causes would be likely in the same population over their lifetimes.

The annual radiation dose to the involved worker population would be 1,344 person-rem, which could result in 0.54 latent cancer fatalities. Closure actions under the Clean and Remove Tanks Alternative would result in 0.2 latent cancer fatalities per year. In addition, doses to individual workers would be kept below the regulatory limit of 5,000 mrem per year (10 CFR 835). Furthermore, as low as reasonably achievable principles would be exercised to maintain individual worker doses below the SRS Administrative Control Level of 500 mrem per year. Tank closure activities would add minimal amounts to the overall radiological health effects of the workers and general public.

5.4 Waste Generation and Disposal Capacity

As stated in Section 4.1.10, HLW, low-level waste, and hazardous/mixed waste would be generated from tank closure activities.

Table 5-4 lists cumulative volumes of HLW, low-level, transuranic, and hazardous and mixed wastes that SRS would generate. The table includes data from the SRS 30-year expected waste forecast. The 30-year expected waste forecast is based on operations, environmental restoration, and decontamination and decommissioning waste forecasts from existing generators and the following assumptions: secondary waste from the DWPF, a form of HLW salt processing (In-Tank Precipitation), and Extended Sludge Processing operations are addressed in the DWPF EIS; HLW volumes are based on the selected option for the F-Canyon Plutonium Solutions EIS and the Interim Management of Nuclear Materials at SRS EIS; some investigation-derived wastes are handled as hazardous waste per RCRA regulations; purge water from well samplings is handled as hazardous waste; and the continued receipt of small amounts of low-level waste from other DOE facilities and nuclear naval operations would occur. The estimated quantity of radioactive/hazardous waste from operations in this forecast during the next 30 years would be approximately 143,000 cubic meters. In addition, radioactive/hazardous waste associated with environmental restoration and decontamination and decommission activities would have a 30-year expected forecast of approximately 68,000 cubic meters. Waste generated from the Clean and Remove Tanks Alternative would add a total of 117,000 cubic meters. During this same time period, other reasonably foreseeable activities that were not included in the 30-year forecast would add an

Table 5-3. Estimated average annual cumulative radiological doses and resulting health effects to offsite population and facility workers.

	Maximally exposed individual				Offsite population[a]				Workers	
Activity	Dose from airborne releases (rem)	Dose from water releases (rem)	Total dose (rem)	Probability of fatal cancer risk	Collective dose from airborne releases (person-rem)	Collective dose from water releases (person-rem)	Total collective dose (person-rem)	Excess latent cancer fatalities	Collective dose (person-rem)	Excess latent cancer fatalities
SRS Baseline[b]	7.0×10^{-5}	1.2×10^{-4}	1.9×10^{-4}	9.5×10^{-8}	3.5	1.8	5.3	2.7×10^{-3}	160	0.066
Tank Closure[c]	5.2×10^{-8}	(f)	5.2×10^{-8}	2.6×10^{-11}	3.0×10^{-3}	(f)	3.0×10^{-3}	1.5×10^{-6}	490	0.20
Other foreseeable SRS activities[d]	5.1×10^{-5}	5.7×10^{-5}	1.1×10^{-4}	5.4×10^{-8}	3.4	0.19	3.6	1.8×10^{-3}.	694	0.28
Plant Vogtle[e]	5.4×10^{-7}	5.4×10^{-5}	5.5×10^{-5}	2.7×10^{-8}	0.042	2.5×10^{-3}	0.045	2.1×10^{-5}	NA	NA
Total	1.2×10^{-4}	2.3×10^{-4}	3.5×10^{-4}	1.8×10^{-7}	6.9	2.0	8.9	4.5×10^{-3}	1,344	0.54

N/A = not available

a. A collective dose to the 50-mile population for atmospheric releases and to the downstream users of the Savannah River for aqueous releases.

b. Arnett and Mamatey (1999) for 1998 data for MEI and population. Worker dose is based on 1997 data (WSRC 1998).

c. Collective worker dose of 490 person-rem is based on closure of two tanks per year for the Clean and Remove Tanks Alternative (Table 4.1.8-2).

d. Includes Spent Nuclear Fuel, Highly Enriched Uranium, Tritium Extraction Facility, Management of Certain Plutonium Residues and Scrub Alloy Concentrations, Defense Waste Processing Facility, and Disposition of Surplus Plutonium, Sodium-Bonded Spent Nuclear Fuel, and components from throughout the DOE complex.

e. NRC (1996).

f. Less than minimum reportable levels.

Table 5-4. Estimated cumulative waste generation from SRS concurrent activities (cubic meters).

Waste type	SRS baseline[a,b]	Tank closure[c]	ER/D&D[b,d]	Other waste volume[e]	Total
HLW	14,000	97,000	0	80,000	191,000
Low-level	119,000	19,260	61,600	251,000	450,000
Hazardous/mixed	3,900	470	6,200	4,700	15,200
Transuranic	6,000	0	0	12,500	18,500
Total[f]	143,000	117,000	67,800	348,000	675,000

a. Source: Halverson 1999.
b. Based on a total 30-year expected waste generation forecast, which includes previously generated waste.
c. Waste volume estimates based on the Clean and Remove Tanks Alternative (Table 4.1.10-2).
d. ER/D&D = environmental restoration/decontamination & decommissioning; based on a total 30-year expected waste forecast.
e. Sources: DOE (1996, 1997, 1998a,b, 1999b,c, 2000b,c). Life-cycle waste associated with reasonably foreseeable future activities such as spent nuclear fuel management, tritium extraction facility, plutonium residues, surplus plutonium disposition, highly-enriched uranium, commercial light water reactor waste, sodium-bonded spent nuclear fuel, and weapons components that could be processed in SRS canyons. Impacts for the last two groups are based on conventional processing impacts of spent nuclear fuel "Group A"; DOE (2000c).
f. Totals have been rounded.

additional 348,000 cubic meters. The major contributor to the other waste volumes would be from weapons components from various DOE sites that could be processed in SRS canyons and from SNF management activities. Therefore, the potential cumulative amount of waste generated from SRS activities during the period of interest would be 675,000 cubic meters.

This large quantity of radioactive and hazardous waste must be managed safely and effectively to avoid severe impacts to human health and the environment. Such management is a major component of new missions for DOE. DOE has facilities in place and is developing new ways to better contain radioactive and hazardous substances. It is important to note that the quantities of waste generated are not equivalent to the amounts that will require disposal. For example, HLW is evaporated and concentrated to a smaller volume for final disposal.

The Three Rivers Solid Waste Authority Regional Waste Management Center at SRS accepts non-hazardous and non-radioactive solid wastes from SRS and eight surrounding South Carolina counties. This municipal solid waste landfill provides state-of-the-art Subtitle D (non-hazardous) facilities for landfilling solid wastes while reducing the environmental consequences associated with construction and operation of multiple county-level facilities (DOE 1995b). It was designed to accommodate combined SRS and county solid waste disposal needs for at least 20 years, with a projected maximum operational life of 45 to 60 years (DOE 1995b). The landfill is designed to handle an average of 1,000 tons per day and a maximum of 2,000 tons per day of municipal solid wastes. SRS and eight cooperating counties had a combined generation rate of 900 tons per day in 1995. The Three Rivers Solid Waste Authority Regional Waste Management Center opened in mid-1998.

Tank closure activities and other planned SRS activities would not generate larger volumes of radioactive, hazardous, or solid wastes beyond current and projected capacities of SRS waste storage and/or management facilities.

5.5 Utilities and Energy

Table 5-5 lists the cumulative total of water consumption from activities at SRS. The values are based on annual consumption estimates. DOE has also evaluated the SRS water needs during tank closure. At present, the SRS rate of groundwater withdrawal is estimated to be a maximum of 1.7×10^{10} liters per year. The maximum estimated amount of water needed annually for the Grout Option under the Clean

Table 5-5. Estimated average annual cumulative water consumption.

Activity	Water usage[a] (liters)
SRS Baseline	1.70×10^{10}
SRS HLW Tank Closure[b]	8.65×10^{6}
Other foreseeable SRS activities[c]	8.84×10^{8}
Total	1.79×10^{10}

a. Includes groundwater and surface-water usage.
b. Based on the Grout Option under the Clean and Stabilize Tanks Alternative (Table 4.1.11-1).
c. Includes Spent Nuclear Fuel, Highly Enriched Uranium, Tritium Extraction Facility, Management of Certain Plutonium Residues and Scrub Alloy Concentrations, Defense Waste Processing Facility, and Disposition of Surplus Plutonium, Sodium-Bonded Spent Nuclear Fuel, and components from throughout the DOE complex.

and Stabilize Tanks Alternative would increase this demand by less that 0.1 percent (Table 5-5) when added to present groundwater withdrawals and that for other foreseeable SRS activities. This level of water withdrawal is not expected to exceed SRS capacities.

Overall SRS electricity consumption would not be impacted by tank closure activities. Electricity usage for tank closure would be similar to current consumption levels in F- and H-Tank Farms Area.

5.6 Closure – Near-Term Cumulative Impacts

The above analysis demonstrates minimal cumulative impacts due to the increment of near-term (2000-2030) tank-closure activities for the five resource areas that required evaluation. Table 5-6 summarizes the near-term cumulative impact of past, present, proposed, and other reasonably foreseeable actions for the resource areas presented in this chapter.

5.7 Long-Term Cumulative Impacts

SRS personnel have prepared a report, referred to as the *Composite Analysis* (WSRC 1997), that calculated the potential cumulative impact to a hypothetical member of the public over a period of 1,000 years from releases to the environment from all sources of residual radioactive material expected to remain in the SRS General Separations Area which contains all of the SRS waste disposal facilities, chemical separations facilities, HLW tank farms, and numerous other sources of radioactive material. The impact of primary concern was the increased probability of fatal cancers. The *Composite Analysis* also included contamination in the soil in and around the HLW tank farms resulting from previous surface spills, pipeline leaks, and Tank 16 leaks as sources of residual radioactive material. The *Composite Analysis* considered 114 potential sources of radioactive material containing 115 radionuclides.

The *Composite Analysis* calculated maximum radiation doses to hypothetical members of the public at the mouth of Fourmile Branch, at the mouth of Upper Three Runs, and on the Savannah River at the Highway 301 bridge. The estimated peak all-pathway dose (excluding the drinking water pathway) from all radionuclides was 14 mrem/year (7×10^{-7} fatal cancer risk to a hypothetical member of the public at the mouth of Fourmile Branch), 1.8 mrem/year (mouth of Upper Three Runs), and 0.1 mrem/year (Savannah River). The major contributors to dose were tritium, carbon-14, neptunium-237, and isotopes of uranium (WSRC 1997). These impacts are small because they are substantially below the NRC (and DOE) exposure limit of 100 mrem/yr for offsite individuals.

The analysis also calculated radiation doses from drinking water in Fourmile Branch and Upper Three Runs. The estimated peak drinking water doses from all radionuclides for these

Table 5-6. Summary of short-term cumulative effects on resources from HLW tank closure alternatives.

Resource	Key Indicator of Environmental Impacts	Past Actions	Present Actions	HLW Tank Closure Alternatives	Other Future Actions	Cumulative Effect
Air	24-hour sulfur dioxide concentration	No residual impacts remain from past emissions.	Conservatively estimated to be 96 percent of applicable standard	Incremental increase from the Saltstone Option under the Clean and Stabilize Tanks Alternative is about 0.03 percent of present condition.	Increment about 0.33 percent of present condition.	Unchanged by proposed and other future actions.
Water	Tritium to onsite streams	No residual impacts of past direct discharges. Tritium in the Savannah River was a small fraction of federally mandated limit.	Largest contributor to dose from drinking water dramatically reduced from past operations.	No addition of tritium to Upper Three Runs under any tank closure alternative.	Very small addition of tritium to Upper Three Runs.	No meaningful increment from present, satisfactory conditions.
Health	Annual radiological dose to offsite maximally exposed individual	All-pathway dose of 1.6 mrem is small fraction of 100 mrem limit	All-pathway dose of 0.07 mrem is very small fraction of 100 mrem limit	All pathway dose from the Saltstone Option under the Clean and Stabilize Tanks Alternative is less than 0.1 percent of current dose of 0.07 mrem (which is a small fraction of the 100 mrem limit).	Approximately 60 percent of current dose of 0.07 mrem (which is a small fraction of the 100 mrem limit).	All pathway dose of 0.12 mrem is small fraction of 100 mrem limit.
Waste management	High-level waste (HLW) generation	Large, continual quantities of HLW generated.	Less annual generation, minimal additional tank space needed, 34 million gallons in storage	About 50 percent of cumulative total from the Clean and Remove Tanks Alternative	Highly radioactive fraction immobilized in DWPF. Separated, low activity waste disposed in onsite vaults	Actions initiated to handle this substantial quantity (191,000 cubic meters) of HLW with minimal impact to human health and the environment.
Utility and Energy	Annual withdrawal of groundwater	No cumulative impact to aquifer from past high withdrawals	Aquifer is not stressed by annual withdrawals of 1.7×10^{10} liters.	Very small fraction (0.05 percent) of current withdrawals from the Grout Option under the Clean and Stabilize Tanks Alternative.	Moderate increase (13 percent) in groundwater withdrawals	Potential cumulative impacts are not added to by the proposed action.

creeks were 23 mrem/year (1.2×10^{-5} fatal cancer risk to a hypothetical member of the public at Fourmile Branch) and 3 mrem/year for Upper Three Runs (WSRC 1997).

In this EIS, DOE estimated peak doses over a 10,000 year period of analysis. The highest estimated radiation dose in these creeks from the No Action Alternative, the first location where it could interact with contaminants from these other facilities, is 2.3 mrem/year. The location for which this value is calculated is upstream of the location presented in the Composite Analysis. DOE expects additional dilution to occur as the contaminants from HLW tank closure activities move downstream. Therefore, the dose and the associated impact (1.2×10^{-6} fatal cancer risk to a hypothetical member of the public) from HLW tank closure activities would be a small fraction of the doses due to the other activities analyzed in the Composite Analysis.

In addition, the peak radiation doses from HLW tank closure activities would occur substantially later in time than the impacts of the other activities evaluated in the *Composite Analysis*. For example, because the radioactive contamination in the soil in and around the HLW tanks farms does not have the benefit of a concrete layer below or above it (as would the residual activity remaining in the closed HLW tanks under the fill with grout option), these contaminants would reach the groundwater (and thus the seepline and the surface water) long before the contaminants in the in the closed HLW tanks. Therefore there would be no overlap in time of these contaminants.

As described in Section 4.2.4, DOE has developed a future use policy for the SRS. A key component of this policy is that residential uses of all SRS land would be prohibited in any area of the site. This policy also states that SRS boundaries would remain unchanged, and the land would remain under the ownership of the Federal government. The area around the General Separations Area would remain an industrial use zone. Residential uses of the General Separations Area would be prohibited under any circumstances.

The future condition of the F- and H-Area Tank Farms would vary among the alternatives. Under the No Action Alternative, structural collapse of the tanks would create unstable ground conditions and form holes into which workers or other site users could fall. Neither the Clean and Stabilize Tanks Alternative nor the Clean and Remove Tanks Alternative would have this safety hazard, although there could be some moderate ground instability with the Clean and Fill with Sand Option. For the Clean and Stabilize Tanks Alternative, four tanks in F-Area and four tanks in H-Area would require backfill soil to be placed over the top of the tanks. The backfill soil would bring the ground surface at these tanks up to the surrounding surface elevations to prevent water from collecting in the surface depressions. This action would prevent ponding conditions over these tanks that could facilitate the degradation of the tank structure. For the Clean and Remove Tanks Alternative, the tank voids remaining after excavation would be filled in. The backfill material would consist of a soil type similar to the soils currently surrounding the tanks.

From a land use perspective, the F- and H- Area Tank Farms are zoned Heavy Industrial and are within existing heavily industrialized areas. The alternatives evaluated in this EIS are limited to closure of the tanks and associated equipment. They do not address other potential sources of contamination co-located with the tank systems such as soil or groundwater contamination from past releases or other facilities. Consequently, future land use of the Tank Farms areas is not solely determined by the alternatives for closure of the tank systems. For example, the Environmental Restoration program may determine that the Tank Farms areas should be capped to control the spread of contaminants through the groundwater. Such decisions would constrain future use of the Tank Farms areas. The Clean and Stabilize Tanks Alternative would render the Tank Farms areas least suitable for other uses, as the closed grout-filled tanks would remain in the ground. The Clean and Remove Tanks Alternative would have somewhat less impact on future land use since the tank systems would be removed. However, DOE does not expect the General Separations Area, which surrounds the F and H-Area Tank Farms, to be available for other uses making future uses of the Tank Farms areas a moot point.

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